

### **REMARKS**

Claims 1-37 are pending in this application. Claims 14-16 and 25-37 have been withdrawn as directed to non-elected subject matter. Applicants expressly reserve the right to file one or more divisional applications directed to the subject matter recited in the withdrawn claims. Claims 1-13 and 17-24 have been examined on their merits, and have been objected to and rejected under 35 U.S.C. § 102. In response to the Office Action, Applicants amend claims 1, 4, 6, 7, 10-13, 17 and 24; and cancel claims 2-3. No new matter has been added by these amendments.

### **Objections to the Claims**

Claim 6 has been objected to because the claim purportedly requires that the titanium oxide-based photocatalyst contains an additional metal, wherein the metal can be titanium. Claim 6 depends from claim 1. Claim 1 has been amended to recite:

a titanium oxide-based photocatalyst which is characterized by comprising a titanium oxide and an additional metal compound, and developing a photocatalytic activity by irradiation with visible light, the additional metal compound comprising at least one metal halide.

Claim 6 further defines the metal halide as a halide “wherein the metal is at least one selected from Ti, Si, V, Sn, Sb, W, Nb, Bi, P, Mo, Cs, Ge, As, and Ce.” Based on this amendment, Applicants respectfully request that this objection be withdrawn.

Claim 11 has been objected to under 35 U.S.C. § 1.75(c) for failing to further limit the subject matter of a previous claim. Claim 11 further limits claim 1 by defining the titanium oxide as having absorptivity for visible light. All embodiments of the titanium oxide-based photocatalysts recited in claim 1 do not absorb visible light. In some embodiments, the titanium oxide in the titanium oxide-based photocatalyst does not absorb visible light. Additionally, not all titanium oxides that absorb visible light have photocatalytic activity. Thus, claim 11 further limits claim 1 by limiting the titanium oxide to those that absorb visible light. For these reasons, Applicants respectfully request that this objection be withdrawn.

### **Rejections under 35 U.S.C. § 102**

Claims 1-2, 4, 6, 8-12 and 18-21 have been rejected under 35 U.S.C. § 102(b) for

anticipation by Sugawara *et al.* (U.S. Pat. No. 6,071,623).

Sugawara *et al.* is directed to a photocatalytic film comprising titanium oxide and a second amorphous metal oxide (column 2, lines 25-27). Sugawara *et al.* does not teach a titanium oxide-based photocatalyst comprising a metal halide because Sugawara *et al.*'s second amorphous metal oxide is not a metal halide. Accordingly, Sugawara *et al.* fails to teach each and every limitation recited in claim 1, and the claims depending from claim 1 (claims 4, 6, 11, 12, 18-21) because these claims recite an additional metal compound comprising a metal halide.

For the reasons discussed at page 10, Applicants also traverse the rejection of claims 8-10 as anticipated by Sugawara *et al.*

Claims 1-2, 6, 11-12, and 17-18 have been rejected under 35 U.S.C. § 102(b) for anticipation by Kijima *et al.* (WO 01/71055).

Like Sugawara *et al.*, Kijima *et al.* does not disclose a metal halide as the additional metal compound. Instead, Kijima *et al.* is directed to a titanium oxide film comprising niobium oxide. Niobium oxide is not a metal halide. Therefore, Kijima *et al.* fails to teach an additional metal compound comprising a metal halide as recited in claim 1, the claims depending from claim 1 (claims 6, 11-12, and 18) and claim 17.

Claims 1-11, 13 and 17-24 have been rejected under 35 U.S.C. § 102(a) for anticipation by Tanaka *et al.* (U.S. Pat. Publ. No. 2002/187338).

Tanaka *et al.* is directed to a photocatalytic particle comprising titanium dioxide and a photocatalytically inactive ceramic that is present partially on the surface of titanium dioxide particles and that is a salt containing at least one metal selected from an alkaline earth metal, a transition metal and aluminum (Tanaka *et al.*, claims 1, 4, 7, 10-12). The salt may be a phosphate, a condensed phosphate, or the like. However, Tanaka *et al.* does not disclose a photocatalyst comprising titanium oxide and an additional metal compound comprising a metal halide, as recited in amended claim 1, the claims depending from claim 1 (claims 4, 6, 7, 11, 13, 18-24), claim 5 and claim 17.

On page 6, the Office Action contends that Tanaka *et al.* describes photocatalytic particles that include a powder obtained from  $\text{TiCl}_4$ . However, Tanaka *et al.* merely explains the method for producing the photocatalytic particles -- particles of titanium dioxide with no second compound -- not a titanium oxide-based photocatalyst comprising a metal halide. Specifically,

section 0130 describes that “[e]xamples of the photocatalytic particles include a powder obtained from  $\text{TiCl}_4$  aqueous solution or a titanyl sulfate aqueous solution by means of a liquid phase method, and particles obtained through surface treatment of the above particles by use of a polybasic acid salt.” The  $\text{TiCl}_4$  in Tanaka *et al.* is used to produce a titanium-oxide film, not a photocatalyst comprising titanium oxide and a metal halide.

The surface treatment for introducing an inactive ceramic on the surface of titanium dioxide particles is explained in sections 0116-0117 on pages 6 of Tanaka *et al.* Even if  $\text{TiCl}_4$  is used as a starting material to prepare a titanium dioxide powder or particles, the product is a powder or particle of titanium dioxide that does not contain  $\text{TiCl}_4$  or other chlorides. Therefore, the  $\text{TiCl}_4$  is merely used to prepare titanium dioxide particles, and there is no teaching that titanium dioxide particles contain a metal halide as a second compound.

In contrast, claims 1, 5, 17 and their dependants recite an additional metal compound comprising a metal halide. The metal halide is introduced into the titanium oxide by direct contact with titanium oxide or its precursor (specification at pages 7, and 17-18). Contacting titanium oxide and/or its precursors with a reactive medium containing a metal halide causes a chemical reaction to occur between functional groups (for example, hydroxyl groups) existing on the surface of the titanium oxide or its precursor and the metal halide. Thus, the metal halide can be bonded to the surface of titanium oxide. A metal hydride or metal oxide is formed from the bonded metal oxide by post treatment (specification at pages 7-8, and page 18). As stated in the present application at page 18,

[w]hen the metal halide included in the reaction medium is a titanium halide, the metal compound included in the resulting photocatalyst is converted into titanium hydroxide or oxide during post treatment, and the photocatalyst no longer contains a halogen. It is difficult to distinguish the resulting halogen-free post-treated product from a conventional titanium oxide by chemical composition. However, the oxygen defects introduced by a reaction during contact with the reactive medium still remain in the post-treated product and make the product show an ESR spectrum which is different from that of a conventional titanium oxide, thereby making it possible to identify a photocatalyst according to the present invention by an ESR spectrum. Thus, whereas a conventional titanium oxide gives an ESR spectrum which does not show any of the above-described first to third features, an ESR spectrum of a post-treated product according to the present invention shows the first and second features and preferably also the third feature. In addition, it shows the first feature in a wide temperature range from 5 K to room temperature.

Furthermore, the specification states that the metal hydroxide or oxide should be introduced in the titanium oxide via a metal halide reacted with the titanium oxide. Specifically, the specification recites at page 15 that

[t]he metal halide, when allowed to contact with titanium oxide at an elevated temperature, is bound by the surface of the titanium oxide, and at the same time it can reduce the titanium oxide matrix to introduce oxygen defects therein, thus converting the titanium oxide into one capable of absorbing visible light. This effect is particularly significant when a base gas (dilution gas) of the reactive gas contains hydrogen and/or nitrogen, and a photocatalyst having an increase visible light activity can be obtained.

For these reasons, claims 1, 5, 17 and their dependants are not anticipated by Tanaka *et al.*

Also, the ESR spectrum recited in claims 8-10 is not taught by Sugawara *et al.*, Kijima *et al.* or Tanaka *et al.* The features of ESR spectrum recited in claims 8-10 can be achieved by the method recited in claims 14 and 15. They are not achieved with a conventional photocatalyst, even if that photocatalyst contains a second metal oxide as discussed in Sugawara *et al.* or Kijima *et al.* The method disclosed in Tanaka *et al.* also differs from claims 14 and 15, and therefore does not have the ESR characteristics recited in claims 8-10.

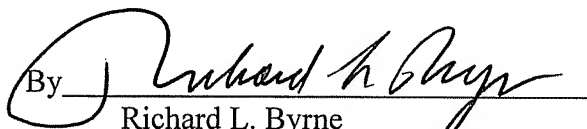
The rejections as pertaining to claims 2 and 3 are moot because these claims have been cancelled.

**Conclusion**

The cited references, alone or in combination with each other, do not teach or suggest the recited invention. Accordingly, Applicants respectfully request that the objections and rejections be reconsidered and withdrawn, and that pending claims 1-13 and 17-24 be allowed.

Respectfully submitted,

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